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Psychological Monographs: General and Applied

Psychological Changes During the First Year Following Prefrontal Lobotomy[1]

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I. INTRODUCTION

Several authors surveying literature pertinent to the area of psychosurgery (9, 10, 11, 13, 18, 22) have generally concurred in three principal conclusions: first, that there is disagreement among experimenters regarding the effect which prefrontal lobotomy has on those functions which psychological tests are designed to measure; second, that certain important psychological variables have been neglected in the various studies; and third, that there is considerable discrepancy between interpretations of test data and clinical impression. The present writers, as a result of their own review of the experimental literature, wish to add a fourth criticism. It is apparent that several investigators have failed to consider basic methodological issues in evolving their experimental procedures. The fourth criticism is important, the writers feel, because it seems that much of the confusion in the field is due to inadequate experimental design. A brief discussion of five types of methodological weakness follows.

A major source of conflicting reports, and one common to many studies, is the matter of timing—i.e., *the length of the interval between pre- and posttestings.* Porteus and Peters (25) have pointed out the importance of having constant intervals between testing, since they have observed that the extent of functional deficit tends to decrease progressively following lobotomy. That is, the postoperative psychological condition is not static, but dynamic and changing. Consequently, an experiment which reports changes a few weeks following operation perhaps cannot be expected to be comparable with experiments which deal with longer or shorter time intervals.

[1] Abstract of this paper read at American Psychological Association, Chicago, September, 1951. From the Veterans Administration, Northampton, Massachusetts.

[2] The writers wish to acknowledge the help of the following people in the research study reported here:

Lionel M. Ives, M.D., Chief of Professional Services, who coordinated the lobotomy program in all its phases, selected the patients, and suggested certain areas for analysis; James C. Fox, Jr., M.D., who, as Consultant in Neurology and Psychiatry, made many thoughtful suggestions and criticisms; Roger Cheney, M.D., Consultant in Neurosurgery, who performed most of the operations, for his willingness to discuss what he was doing and why he was doing it; Robert Garrow, psychiatric aide, and Alphonse Sootkus, R.N., for their patience and cooperation; Howard Blane, John Byrne, Alfred Goldman, Herbert Lipton, Robert Misch, Melvin Rosenthal, and Howard Slepian, intern clinical psychologists, who assisted in the analysis of data and/or some of the testing; Leonard Kogan, Ph.D., Institute for Welfare Research, Community Service Society of New York, and J. Richard Wittenborn, Ph.D., Department of Psychology, Yale University, for statistical advice; Paul I. Yakovlev, M.D., Harvard University School of Medicine, for critical discussion of portions of the paper; Mrs. Ida Metz Hyland, Chief Social Worker, and other members of her department, particularly Miss Elizabeth L. Grover, for getting patients to return for their examinations when they were not in the hospital; Miss Eileen M. Kirby, departmental secretary, for maintaining schedules, recording data, carrying out numerous and tedious but necessary details, and typing this paper through all its many drafts; and Herbert S. Conrad, Ph.D., Editor of the *Psychological Monographs*, for his valuable assistance in preparing this manuscript for publication.

The second criticism holds that *the type of operation*, as an important variable, has not been adequately controlled. No matter how similar the various operative techniques may be, it is still not experimentally wise to interchange results when the patients have been subjected to alternative surgical procedures—e.g., lobotomy, lobectomy, topectomy, and gyrectomy. This is especially true when different areas of the cortex have been severed or removed. King's study of abstraction (20) in the Greystone Project illustrates the point, where differing results were found to be dependent upon the area ablated.

Many studies in the literature fail to supply the *control groups* which are necessary for establishing the base lines in terms of which changes due to lobotomy must be evaluated. Conclusions drawn from an experimental group, without first ascertaining that the changes observed are not due to some other variable than lobotomy, are at best tentative. Zubin (37), for example, found that Rorschach changes in control patients were often in the same direction as in the case of operated patients.

A fourth criticism has really two parts, both related to the problem of diagnostic classification. First, in some studies *the experimental groups are not homogeneous*—i.e., the lobotomized patients may include neurotics, psychotics, cases of brain damage, and cases of intractable pain. It cannot be assumed that lobotomy would have similar effects on such varied patients, since the preoperative conditions—i.e., the psychological organizations—are so disparate. For the same reason conclusions drawn from *homogeneous groups representing different diagnostic categories* should not be expected to be identical. For example, certain experiments have been interpreted to refute the findings of other experiments when in reality the "discrepant" studies have dealt with populations having different characteristics.

The fifth and last criticism refers to *the limited or atomistic viewpoint* which apparently determines the interpretation of psychological data in many studies. There has been little attempt made to integrate test findings with clinical data. Mettler (23) has pointed out the difficulties involved in such an approach and offers reasons for not having attempted it in the Greystone Project. It is the opinion of the authors, however, that unless all available data (from the case history, clinical observations, psychological tests, etc.) are integrated into a cohesive picture, only isolated information concerning the effect of lobotomy on behavior will be achieved. A methodological approach designed to answer this criticism will be described in the following section.

II. METHODOLOGY: SUCCESSIVE VERIFICATION OF HYPOTHESES

The experiment reported in this paper employed an extensive battery of psychometric and projective tests which was administered to the lobotomized patients about two weeks before operation, and two weeks, three months, and one year following. A group of control patients was tested at comparable intervals. The tests used and the selection of patients will be described in greater detail in succeeding sections. The remainder of this section offers a description of the methodology evolved by the authors—a threefold approach to the analysis of data.

Since statistical treatment alone cannot adequately characterize or portray changes which occur over the various time intervals, and since a purely qualitative consideration could not be sufficiently rigorous (for reasons given below), a method was developed which attempts to utilize both the quantitative and the qualitative aspects of the data. This approach appears to have several advantages over methods previously reported in the literature: (*a*) it permits consideration of individual differences which are sometimes masked by statistical techniques; (*b*) it minimizes the tendency sometimes found in qualitative analysis to prejudge data and to form *ad hoc* explanations; (*c*) it makes it possible to test qualitative deductions statistically; (*d*) it enables the experimenters to investigate more completely the pattern of behavioral changes during the postoperative period.

Although there are certain advantages to the type of qualitative approach used in this experiment, there are also some weaknesses. One aim of such an analysis was to develop a configurational picture of the patient, but in doing

so the various components (test scores, history data, etc.) were neither equally weighted nor clearly defined. Moreover, the theoretical point of view espoused by the writers was a mixture of the thinking of Freud, Lewin, and some of the psychobiologists; it was not possible to be completely consistent in theoretical perspective when evaluating the results from successive time intervals, or even from one test to another within the same "time slice." Also, of course, the writers' biases—derived from extensive reading of the literature on brain damage in general, and on lobotomy in particular—have their effects on the treatment of data. Finally, it has proved extremely difficult, if not actually impossible, to keep in mind the configuration of hundreds of test scores and clinical items in terms of which the authors attempted to appraise each specific test change and its interpretative significance. Such an evaluation of test changes must take into account the alterations in the personality structure which occur as a result of (*a*) lapsed time, or those variables which are operative during the time lapse; (*b*) the altered interpersonal environment; and (*c*) changes in functions which are correlated with the specific function being examined. There is also, in the type of analysis used here, a tendency to subsume tests under broad categories in order to develop generalized rationales. The difficulty is that the rationale may be only more or less valid, thereby contributing to a false interpretation of the patient's psychological status. Finally, the last weakness pertains to the evaluation of scores on particular tests in a battery which is repeatedly administered. The tendency has been to interpret scores in the light of previous administrations of the battery, neglecting the interrelationships between measures from other tests. The authors feel that the significance of a score should be determined in terms of the matrix in which it occurs—i.e., in terms of the scores on the other tests of the battery at one particular administration. This aim, however, is most difficult, if not impossible, to achieve. One is usually compelled to treat merely the fluctuations which occur in each individual test from one administration to the next.

A more detailed description of our particular approach will now be attempted; it involved three stages of analysis.

The first step in the analysis of data was to formulate an integrated picture of the prelobotomy personality structure of each of a small sample of patients, and then to employ this unique configurational pattern as a frame of reference for evaluating postoperative changes. Prelobotomy test findings were integrated with all the other types of information concerning the patient, i.e., social history, psychiatric reports, ward observation notes, and behavior in the testing situation. (Excerpts from a forthcoming article dealing with this matter will be found in Appendix A.) These data were analyzed using two levels of inference. The first level involved primarily the study of ego intactness or reality testing; the second level dealt with the etiological variables within the personality constellation. Reality testing was defined in terms of performance on tests which are designed to reflect the efficiency of certain cognitive or ego functions such as attention, concentration, abstraction, memory, etc. Personality dynamics were formulated on the basis of the patient's performance and behavior in projective test situations. These interpretations were made in terms of various theoretical biases which were not as operationally determinable as those used with the first level data. Each test was then examined at the four time intervals in terms of the general configuration of ego functioning and the brief formulations of personality dynamics. Score changes were evaluated not only with respect to the single specific test, but also in relation to the pattern of changes in all tests of similar nature. From this analysis were derived tentative conclusions as to the nature of the changes which occur in the reorganization of personality following lobotomy. As mentioned, the foregoing detailed analysis was carried out on a small sample of the lobotomized group; a similar analysis, though not so exhaustive, was done with the other members of the experimental group.

The second step in the analysis of data,

carried out by independent judges concurrently with the intra-individual analysis just described, was the longitudinal study of all patients on each single test. An example of this type of analysis will be found in Appendix B. The attempt here was to examine the change in the lobotomy group over the total period of time, i.e., over the course of one year. This involved the determination of those changes which occurred in each population (experimental and control) at the various time intervals. This test-by-test longitudinal analysis afforded impressions as to change or lack of change in variables reflecting adjustment in such areas as motor, emotional, social, etc. Those impressions which were in accord with the tentative conclusions derived from the intra-individual analysis were retained as working hypotheses for the third phase of the analysis.

The third phase of the analysis consisted of statistical tests of the four hypotheses derived from the individual case studies and the longitudinal analyses. Tests were made of the statistical significance of the net change in means for the experimental (lobotomized) group for each of six time periods: (*a*) preoperation to two weeks post; (*b*) pre to three months post; (*c*) pre to one year post; (*d*) two weeks post to three months post; (*e*) two weeks post to one year post; and (*f*) three months post to one year post. Since not all subjects could be tested on all variables at each occasion, either because of lack of cooperation or unavailability due to illness, trial visit, etc., the sample of patients varies from a maximum of 22 to a minimum of 13.[3] Also, because the same subjects could not be fully tested on each occasion, the data utilized in the statistical analyses are based on a sample which varies in maximum size from 22 to 12. Since only nine subjects in each group took all the tests on each occasion, the statistical analyses are based on data from those individuals who took a given test on at least two occasions.

The existence of incomplete data, the small number of subjects, the small number of administrations of the tests, and the large number of variables (which are not all independent) precluded the use of factor analytic methods. Further, the lack of normality of the distributions of scores and the lack of homogeneity of variance suggested that analysis of variance or covariance was not feasible. It was decided, therefore, to test the statistical significance of the *net change* in the experimental group, in spite of the untenable basic assumption that initial and final scores have a one-to-one relationship.

The formula employed for testing net change, using raw scores and small sample techniques, is as follows:

$$t=\frac{\frac{\Sigma(Y-X)}{N}-\frac{\Sigma(Y'-X')}{N'}}{\sqrt{\frac{N\Sigma(Y-X)^2-[\Sigma(Y-X)]^2}{N^2(N-1)}+\frac{N'\Sigma(Y'-X')^2-[\Sigma(Y'-X')]^2}{N'^2(N'-1)}}}$$

where X and X' are initial raw scores in the experimental and control groups, Y and Y' are final raw scores in the experi-

[3] Tables giving the number of cases, mean, and standard deviation for each variable for the total sample have been deposited with A.D.I. For tables order Document 3908 from American Documentation Institute, c/o Library of Congress, Washington 25, D.C., remitting $2.25 for microfilm (images 1 inch high on 35 mm. motion picture film) or $5.00 for photostats readable without optical aid.

TABLE 1
DESIGN OF STATISTICAL ANALYSIS

Experimental				Control			
1st test	2nd test		Total	1st test	2nd test		Total
	Below	Above			Below	Above	
Above	A	B	$A+B$	Above	A'	B'	$A'+B'$
Below	C	D	$C+D$	Below	C'	D'	$C'+D'$
Total	$A+C$	$B+D$	N	Total	$A'+C'$	$B'+D'$	N'

$A, B \cdots D'$ are cell frequencies, $Z = \frac{N'(|D-A|-1)-N(|D'-A'|-1)}{\sqrt{N'^2(A+D)+N^2(A'+D')}}$. Z is evaluated from entries in the normal probability table.

mental and control groups, $df = N + N' - 2$.

Although the distributions were skewed, it was not felt that transformations of raw scores were warranted in this experiment. By using raw scores the chances of obtaining statistical significance were actually reduced, since the standard error of the difference between means was inflated relative to the displacement of the means. It was felt, therefore, that if significant results were obtained with skewed data, nothing would be gained through transformation. The few variables for which a true difference in means seemed to be masked by inflation of the standard error were dichotomized by splitting the obtained distributions at the median of the combined distribution of preoperation test scores and tested as described in the next paragraph.

Dichotomized data were tested for the significance of the net shift in proportions by a formula adapted by Kogan[4] from McNemar (21) which corrects for continuity. Fourfold tables were developed for each group (Table 1).

This paper deals primarily with the final stage of the threefold analysis and reports the results of the statistical tests of the four hypotheses which were derived from the extensive case material and the longitudinal study of tests. The authors realize that their method of successive verification of hypotheses does not constitute cross validation in the usual sense, since the same total population was used throughout. There were differences between samples used in the three stages of analysis, however, which make for reduction of contamination. Intensive case reports were promulgated for only two or three lobotomized patients, although all experimental records were briefly surveyed. Longitudinal analyses of tests are based on the total sample of patients tested on any single occasion. Finally, the statistical analysis is based on those individuals who were tested on at least two occasions. The fact that each judge in the first two phases of the analysis worked independently, without knowledge of his co-workers' results, also serves to reduce *ad hoc* thinking.

[4] Personal communication. January 4, 1950.

III. EXPERIMENTAL PROCEDURE

A. Subjects

Forty-four subjects were used in this experiment, all of whom were psychotic male patients in the Veterans Administration Hospital, Northampton, Massachusetts. Twenty-two of these patients,

the experimental group, underwent bilateral prefrontal lobotomy. A control group of 22 patients was fairly well equated with the operated group for age, sex, education, length of hospitalization, cooperation level, diagnosis, and certain behavior characteristics (e.g., assaultiveness, talkativeness, etc.).

The experimental group averaged 33.9 (*S.E.* 1.3) years of age, had received 10.8 (*S.E.* 0.5) years' education, and had been hospitalized for 4.09 (*S.E.* 0.5) years. The control group averaged 30.4 (*S.E.* 1.0) years in age, had received 10.05 (*S.E.* 0.7) years' education, and had been hospitalized 3.3 (*S.E.* 0.4) years. Fourteen experimental and eleven control patients manifested an unusually high level of cooperation. The experimental group was made up of five paranoid schizophrenics, eight catatonics, four hebephrenics, and five schizophrenics, mixed type. The control group consisted of four paranoid schizophrenics, eight catatonics, two hebephrenics, and eight schizophrenics, mixed type. All 44 patients had been approved for lobotomy by a board of psychiatrists following an unsuccessful course of electroconvulsive shock treatment, and were receiving the same types of adjunctive therapy.

The authors wish to point out that the control conditions were not as complete as they would like, since the control patients did not undergo a "mock" operation.

B. Procedure

Twenty-nine tests comprised the psychological battery which was employed in this experiment, from which 145 variables were derived. Most of the variables were selected before testing was begun; all of them were selected before any analysis was commenced. The battery was administered to the experimental group about two weeks before, and two weeks, three months, and one year following bilateral prefrontal lobotomy. The control group was tested at comparable time intervals.

In order to define more clearly the type of operative procedure that was used, the following excerpt is quoted from the neurosurgeon's report of a typical standard, open Lyerle-Poppen prefrontal lobotomy.

> Under local pentothal anaesthesia, the usual skin incisions were placed in plane of pupil parallel to the sagittal sinus 3½ cm. from the midline. Trephine openings were made 2 cm. anterior to the coronal suture and the bone buttons removed. Transverse cortical incision was made and the sphenoid ridge identified by the use of the brain cannula. The plane of section was then made through the frontal lobes passing 1 cm. anterior to the tip of the frontal horn bilaterally. There was no difficulty with hemostasis. The ventricles were not encountered. Silver clip markers were placed and the wound irrigated.

The tests were administered in group fashion whenever practicable. Those tests which have published manuals were scored according to the prescribed method; the evaluation of qualitative data was achieved by the group judgment of three clinical psychologists.

Analyses, as described in the preceding section on methodology, were made for six time periods: (*a*) preoperation to two weeks post; (*b*) pre to three months post; (*c*) pre to one year post; (*d*) two weeks post to three months post; (*e*) two weeks post to one year post; and (*f*) three months post to one year post.

C. Test Materials

A complete list of tests and variables follows.

1. *Digit Symbol.*
   Subtest 10 from the Wechsler-Bellevue Scale of Adult Intelligence (34). Administered group fashion with Wechsler's directions, time limit, and weighted scores.
   (1) Errors, number of
   (2) Weighted score
2. *Digit Span.*
   Subtest 4 from the Wechsler-Bellevue Scale

(34). Administered individually with standard directions and scoring.

(3) Digits forward, number of
(4) Digits reversed, number of
(5) Weighted score

3. *Successive Subtraction.*

Oral serial subtraction of 7 from 100 (35), given individually. Adding instead of subtracting, or subtracting 10 instead of 7 are interpreted as rigidity.

(6) Time, in seconds
(7) Errors, number of
(8) Rigidity, presence-absence

4. *Hard Pairs.*

Subtest 3 from the Hunt-Minnesota Test for Organic Brain Damage (16); a list of 10 word pairs. Given individually with a single reading of the paired words and a single test for the number of correct associations to the stimulus word in each pair.

(9) Correct associations, number of

5. *Visual Memory.*

The Benton Visual Memory Test (4); geometric designs to be reproduced from memory, individually administered. In addition to the number of correct reproductions, certain formal aspects of the drawings were scored.

(10) Correct designs, number of
(11) Size, rated on 5-point scale
(12) Retracing of lines, presence-absence
(13) Difficulty with reproduction of angles, presence-absence
(14) Heaviness of lines, presence-absence
(15) Lightness of lines, presence-absence
(16) Waviness of lines, presence-absence

6. *Vocabulary.*

Subtest 5A from Wechsler-Bellevue Scale (34). Given group fashion; patients were asked to write meanings of words printed on test sheet. Standard scoring procedure used. The derived score was used as a base line against which to compare performance on the Memory Paragraph and on the Shipley-Hartford Scale.

(17) Weighted score

7. *Memory Paragraph.*

Test 6 from Babcock-Levy battery (2), administered in group fashion by having patients write whatever they recall of an orally presented paragraph. There were two recalls, the sequence being: (*a*) reading of stimulus material to group; (*b*) immediate written recollection; (*c*) re-reading of the paragraph; (*d*) 10 minutes of interpolated testing using other nonrelated materials; (*e*) another written recall. A memory efficiency score was obtained by forming a ratio of the average number of correct memories on the two recalls to the vocabulary weighted score.

(18) Immediate correct memories, number of
(19) Distortions of content in immediate recall, number of
(20) Distortions of order in immediate recall, presence-absence
(21) Correct memories in delayed recall, number of
(22) Distortions of content in delayed recall, number of
(23) Distortions of order in delayed recall, presence-absence
(24) Average number of correct memories on the two recalls
(25) Average number of distortions of content on the two recalls
(26) The memory efficiency score, described above
(27) Number of correct memories in delayed recall minus the number in immediate recall
(28) Number of distortions in delayed recall minus the number in immediate recall

8. *Finger Dexterity.*

An adaptation of Johnson O'Connor's Worksample #16 (24), using the tweezer dexterity plate instead of the one prescribed. Administered individually, patients are required to place 50 pins, using the fingers of the dominant hand, in 5 rows of 10 pins each.

(29) Time, in seconds

9. *Dynamometer.*

A standard hand dynamometer employed in a situation designed to yield a measure of level of aspiration. Given individually, the patient is asked to squeeze the apparatus as hard as possible. After being informed of his score, he is asked to state how hard he thinks he can squeeze it on a second trial.

(30) Direction of goal (up, down, same)

10. *Tweezer Dexterity.*

An adaptation of Johnson O'Connor's Worksample #17 (24). The trials are run in an individual situation. The patient is required, using a tweezer in his dominant hand, to place 30 pins in 3 rows of holes, 10 in each row. The patient is asked to predict his performance on the second trial from a knowledge of his performance on the first trial.

(31) Total time, in seconds, for the two trials
(32) Direction of goal

11. *Steadiness Test.*

An adaptation of Halstead's Manual Steadiness Test (14), individually administered, where the patient's task was to run through two trials of placing a stylus in a series of progressively smaller holes, trying not to touch the sides. The patient is asked to predict his performance on the second trial from a knowledge of the first.

(33) Total number of contacts on the two trials
(34) Direction of goal

12. *Downey Inhibition Test.*

Subtests VI-2 and VII from the Downey Group Will-Temperament Test (7), given in a group situation. The former task requires the subject to write "United States of America" as rapidly as possible; in the latter the patient is

asked to trace a scroll of dotted lines as slowly as possible.

(35) Time for USA, in seconds
(36) Total time for tracing scroll, in seconds, for 3 trials (interpreted as measure of inhibition)
(37) Difference, in seconds, trial 3 minus trial 1

13. *Halstead Tactual.*

Halstead's modification of the Seguin-Goddard Formboard (14). The patient, blindfolded, was required to place ten variously shaped blocks in their appropriate holes on a board erected 70 degrees from the horizontal. There were three trials—right hand, left hand, both hands—after which the patient was asked to reproduce the formboard from memory with paper and pencil. A measure of learning was obtained by determining the time difference between the first and succeeding trials; certain formal aspects of the drawings were also scored. Individually administered.

(38) Right hand, time in seconds
(39) Left hand, time in seconds
(40) Both hands, time in seconds
(41) Difference between right and left hands, in seconds
(42) Difference between right and both hands, in seconds
(43) Shapes correctly drawn, number of
(44) Shapes correctly localized, number of
(45) Perseveration of shape, presence-absence
(46) Heavy lines, presence-absence
(47) Light lines, presence-absence

14. *Object Sorting.*

The test materials, for the most part, corresponded to those described by Goldstein and Scheerer (12) and Reichard and Rapaport (27). Administered group fashion, the objects were placed in the center of a table in full view of the seated patients. Seven stimulus objects were successively presented by the examiner, and the patients were asked to write the name of each and the names of any objects on the table which could belong with each. The patients were also requested to write the reasons for their various sortings. Scoring was based on qualitative evaluation of the active sortings discussed in Rapaport, Gill, and Schafer (26), Goldstein and Scheerer, and from the clinical experience of the senior author. Each sorting was scored once, on a scale from 0 to 3, for correctness or adequacy of the choice of items with reference to the stimulus object, and a second time for the adequacy of the concept or abstraction given.

(48) Total score
(49) Confabulation, presence-absence
(50) Symbolism, presence-absence

15. *Similarities.*

This subtest from the Wechsler-Bellevue Scale (34) was given group style by having the patients write their responses. Standard directions and scoring were used.

(51) Weighted score

16. *Series Completion.*

A speed test from the Army Wechsler (1), given group fashion, where the patient's task is to complete a series of geometric figures by abstracting the relationship which is represented.

(52) Attempted solutions, number of
(53) Correct responses, number of

17. *Shipley-Hartford.*

A subtest from the Shipley-Hartford Retreat Scale (32), similar to Series Completion, but dealing with verbal material. Administered group style. The conceptual quotient, one of Shipley's measures, was determined by finding the ratio of the score on this test of abstraction to the Wechsler vocabulary score.

(54) Attempted solutions, number of
(55) Raw score (twice the number of correct responses)
(56) Conceptual quotient

18. *Categorization.*

This test, originally developed by H. M. Capps (5), was given group fashion. There are 25 test items, each consisting of a stimulus word followed by seven other words. The patient's task is to underline the three words in each item which are related to the stimulus word.

(57) Raw score (the number of correct items)

19. *Trail Making.*

From the Army Individual Test, Form I (38). Although two forms of the subtest, A and B, were given to the patients, only the results of Form B were evaluated. Group administered, the subject's task was to connect successively by drawn line twenty-five randomly spaced circles designated by numbers or letters. Directions and scoring are consistent with standard procedure.

(58 Time, in seconds
(59) Errors, number of

20. *Draw A Woman.*

Given group fashion; the patients were asked simply to draw a woman. The rationale for the selection of particular scoring categories—largely defined in terms of formal characteristics of the drawings—was based principally on unpublished research by Lydia Levy.[8]

(60) Size (on 5-point scale)
(61) Breast size (5-point scale)
(61a) Shift in breast size from one testing to another
(62) Confusion of sex, presence-absence

21. *Draw-A-Man.*

What was said about the Draw-A-Woman Test also applies here, except that the patient was asked to draw a man.

(63) Size (5-point scale)
(64) Nose size (5-point scale)
(65) Accuracy or degree of resemblance to a human figure (5-point scale)
(66) Confusion of sex, presence-absence

[8] Personal communication, 1946.

(67) Head or full-figure representation
(68) Discontinuous lines ("chicken scratching"), presence-absence
(69) Shading (the solid coloring, by pencil, of sizable portions of the figures), presence-absence
(70) Retracing of lines, presence-absence
(71) Heavy lines, presence-absence
(72) Light lines, presence-absence

22. *Bender-Gestalt.*

This test was individually administered by the standard method (3). Formal aspects of the drawings were analyzed and scored; the signs of regression used are those described by Bender (3), Hutt (17), and others.

(73) Size (5-point scale)
(74) Discontinuous lines, presence-absence
(75) Elaboration (the addition of extraneous lines), presence-absence
(76) Retracing of lines, presence-absence
(77) Difficulty with angles, presence-absence
(78) Heavy lines, presence-absence
(79) Light lines, presence-absence
(80) Regression signs, presence-absence

23. *Word Association.*

The word list was that developed by Rapaport, Gill, and Schafer (26). Given group style, the patients were instructed to read the stimulus words and to write beside each one the first word that came to mind. There were two pages, each having thirty words. Upon completion of the task the patients were given another copy of the test and asked to write the same words which they had written the first time.

(81) Percentage of correct recall
(82) Number of omissions (stimulus words not responded to) for first presentation of the 60 words
(83) Phrase responses, number of (first presentation)
(84) Close responses, number of (first presentation)
(85) Distant responses, number of (first presentation)
(86) Clang responses, number of (first presentation)
(87) Personal references, number of (first presentation)
(88) Time, in seconds, for first thirty words

24. *Picture Frustration.*

Group administration by standard procedure of this technique developed by Rosenzweig (30). Only the extrapunitive responses were scored.

(89) Extrapunitive ego-defensive responses, number of

25. *Szondi.*

A single administration of this test was given in a group situation, as opposed to more orthodox methods of administration (6). The pictures were placed on a table in full view of the patients, and each card in a series was identified by a number from 1 to 8. Each patient was given a mimeographed form and instructed to designate those two pictures he liked by placing an "L" next to the appropriate numbers on the form. Two disliked pictures in each of the eight series were also to be chosen and so indicated by writing a "D" by the corresponding numbers. Positive (liked), negative (disliked), and total choices for each vector were scored.

(90-92) *h* choices: liked, disliked, total
(93-95) *s* choices: liked, disliked, total
(96-98) *e* choices: liked, disliked, total
(99-101) *hy* choices: liked, disliked, total
(102-104) *k* choices: liked, disliked, total
(105-107) *p* choices: liked, disliked, total
(108-110) *d* choices: liked, disliked, total
(111-113) *m* choices: liked, disliked, total

26. *Attitude toward God.*

Adapted from Thurstone and Chave's Scale No. 22 (33), administered group fashion. The test consists of 20 statements pertaining to the concept of God; the patients were asked to make a choice of agreement or disagreement with regard to each one. Only those items on which the patient expressed agreement were scored, and these in turn were broken down as to whether they were statements of affirmation or of negation.

(114) Number of affirmative statements agreed with
(115) Number of negative statements agreed with

27. *Aversion Test.*

This is an unpublished scale of 26 items which was constructed by the senior author in collaboration with Dr. James Gibson, its purpose being to reveal attitudes towards certain asocial activities. Scores for each item range from 0 ("would not bother me at all") to 4 ("impossible to consider thinking or doing" the particular activity). Group administered.

(116) Attitude toward killing someone (without danger of punishment)
(117) Attitude toward keeping money found in a purse
(118) Attitude toward staying at home for two months
(119) Attitude toward incestuous thoughts
(120) Attitude toward deviant sexuality (pederasty)
(121) Attitude toward staying at home for one week
(122) Attitude toward masturbation in daytime
(123) Attitude toward eating cooked human flesh (under pressure of hunger with no reprisal)
(124) Attitude toward urination on public street during daytime
(125) Total aversion score (on the 26 items)

28. *Individual Rorschach Examination.*

The Rorschach test was individually administered using standard directions (29). No inquiry was made, and relatively little encouragement

was given, since in this phase of Rorschach examination the authors were primarily concerned with reaction time and rejections.

(126) Rejections, number of
(127-136) Reaction time on each of the 10 cards
(127) Average reaction time, excluding rejected cards

29. *Multiple-Choice Rorschach.*

Given individually immediately following the individual Rorschach, using the same plates. Subjects were asked to pick, from ten choices for each card, the one which best described the plate in question. The choices for card V were taken from Form A of the Harrower-Erickson technique (15); for the other nine cards Form C was used. The poor anatomy responses (F_o) were scored according to the Harrower-Erickson-Steiner manual. Those responses with movement and color determinants were scored on the basis of the recommendations in the manual, the senior author's clinical experience, and the majority agreement of three independent scorings made by staff clinical psychologists.

(138) Rejections, number of
(139) $FC + CF + C/F$ responses, sum of
(140) $C_n + C_{des} + C_{sym}$ responses, sum of
(141) C responses (not including those in 140), number of
(142) Poor anatomy responses (F_o), number of
(143) $H + Hd$ responses, sum of
(144) Sex responses, number of
(145) Shading responses, presence-absence

IV. RESULTS

It will be remembered that in the section on methodology, two types of data analysis were described by means of which hypotheses were derived that could, in turn, be subjected to statistical test. Four major hypotheses were so developed, and will be individually discussed in the following paragraphs.

Hypothesis I

The first hypothesis states that there is a predictable pattern of performance on tests related to organic factors subsequent to the lobotomy operation: immediately following the surgical procedure there will be a decrease in mental efficiency; as recovery from the operation takes place, test performance will return to the preoperative base line or rise slightly above it, reaching a peak at three months postoperation; finally there will be a general decline such that the status one year after operation will be little better than that prior to surgery.

Thirty-nine relatively objective variables believed to measure mental efficiency were selected by the authors and examined as to the statistical significance of the net change in the lobotomized group. The direction of change was predicted by the senior author in advance of this analysis, thereby justifying a one-tailed test of significance. Table 2 gives the predicted change and the observed direction of change for each of the 39 variables at the six time periods. Of the possible 234 changes, we note that there are 68 observed shifts at the .05 level of significance or better, with 54 shifts in the expected direction (either "H" or "L"), while by chance we expect a total of only 23.4 (at the .05 level of significance) to be in the expected direction. The significant results obtained from the table as a whole ($p < .01$) indicate that the qualitative approach used in setting up hypotheses has considerable merit. At each time period, we would expect by chance alone to have 3.9 changes at the .05 level (10% of 39) in either direction. Thus, our results seem to be significant for the pre to two weeks post, two weeks post to three months post, and the two weeks post to one year post comparisons ($p < .01$). There is some doubt as to the validity of the pre- to one year postoperation comparison, since the probability associated with our results is greater than .05 and less than .10. Significant results were not obtained for the pre to three months post and three

TABLE 2

DIRECTION OF NET CHANGE IN VARIABLES RELATED TO HYPOTHESIS I: ORGANICITY, MENTAL EFFICIENCY

(H indicates higher mental efficiency [decreased organicity]; L indicates lower mental efficiency [increased organicity]; — indicates no change in either direction)

Variable	Time Period					
	Pre–2 wk.	Pre–3 mo.	Pre–1 yr.	2 wk.–3 mo.	2 wk.–1 yr.	3 mo.–1 yr.
Expected Change	L	H	H	H	H	L
Organic Signs						
Word Assoc Phrases (83)	L	—	—	—	H	—
Word Assoc Close (84)	L	—	—	H	—	—
Word Assoc Pers Ref (87)	—	—	H	—	H	—
D-A-M Shading (69)	L	—	—	—	H	—
D-A-M Accuracy (65)	—	H	—	H	—	L
B-G Heavy Lines (78)	—	—	—	—	H	—
B-G Elaboration (75)	—	—	—	H	H	—
B-G Retracing (76)	—	—	—	—	H	—
Vis Memory Retracing (12)	—	—	—	H	—	—
Vis Memory Heavy Lines (14)	—	—	—	H	—	L
Abstraction						
Categorization (57)	L	—	—	H	H	—
Similarities (51)	—	—	—	—	—	L
Shipley Rights (55)	—	—	H	—	—	—
Shipley C.Q. (56)	—	—	—	L	—	—
Object Sorting (48)	L	—	—	—	—	—
Motor						
Tweezer Dexterity (31)	L	—	—	H	—	L
Finger Dexterity (29)	—	H	—	H	—	—
Steadiness Test (33)	L	—	—	—	—	—
Downey Total (36)	L	L	—	H	H	H
Downey T.3–T.1 (37)	—	—	—	—	—	L
Halstead Right Hand (38)	L	—	L	—	—	—
Motor Memory						
Halstead Both Hands (40)	L	H	—	H	—	—
Halstead Right-Left (41)	—	—	H	—	—	—
Halstead Right-Both (42)	—	H	—	—	—	—
Memory						
Visual Memory (10)	—	H	—	H	—	—
Hard Pairs (9)	—	—	H	—	—	—
Mem Par Immed Rights (18)	—	—	H	—	—	—
Mem Par Delay Rights (21)	—	—	H	—	—	—
Mem Par Average Rights (24)	—	—	H	—	—	—
Mem Par Delay Distort (22)	—	—	—	—	H	—
Mem Par Average Distort (25)	—	—	—	—	H	—
Digit Span Forward (3)	—	L	—	—	—	—
Digit Span Reverse (4)	—	L	—	L	—	—
Digit Span Wghtd Score (5)	L	L	—	—	—	—
Cognitive						
Digit Symbol Score (2)	—	H	—	H	—	—
Digit Symbol Errors (1)	—	—	—	—	—	H
Vocabulary (17)	—	—	—	—	H	—
Trail Making Errors (59)	—	—	L	—	—	L
Serial Seven Errors (7)	—	L	H	L	L	H
Changes in Expected Direction	11	6	8	12	11	6
Changes in Opposite Direction	0	5	2	3	1	3

months post to one year post comparisons.

At the two-week period, operated patients show less efficiency in eight of the tests found in Table 2 under the subdivisions of motor ability, cognitive efficiency, abstraction, and memory. There are also significant changes in three of the tests purported to reflect the effects of brain damage. At three months, how-

ever, the situation is almost reversed. With the exception of memory for digits forward and reversed, errors on successive subtraction, and inability to inhibit motoric action (Downey), these patients show either a return to, or an increase over, the preoperative efficiency level. The upward trend is most evident in the comparisons between the two-week–three-month period, and the two-week–one-year period. The authors believe that the exceptions to the general upward trend suggest the presence of permanent damage to the brain. At one year postoperation, many of the measures are still above the preoperative base line, but there appears to be a trend from three months to one year in the direction of decreased mental efficiency.

It may be concluded then, in support of the first hypothesis, that performance on the following kinds of tests seems to be influenced by prefrontal lobotomy: abstraction, pursuit of goals, memory, intellectual energy, accuracy of the body image, attention, concentration, and neuromuscular coordination. It is possible that these fluctuations reflect changes in the anatomical structure of the brain. That is, the initial decline may be associated with the lesion resulting from the surgical assault and then, as the lesion heals, the patient also recovers in terms of mental efficiency. There is evidence that pathological tissue changes occur even after the original lesion is "healed," which may account for the later decline. If, then, the changes in psychological function are in fact associated with changes in brain structure, they should be reflected in those tests designed to measure mental efficiency, as well as those tests commonly assumed to indicate the presence of organicity (organically caused malfunctioning).

B. Hypothesis II

The second hypothesis is that following lobotomy there is an increase in the strength of ego boundaries.[6] In order to test this hypothesis the senior author selected 18 test variables—some related to personality and some to mental efficiency—which are assumed to reflect degree of contact with the environment, and predicted the direction of change at the several time periods. The results of the statistical examination are presented in Table 3, where the observed direction of change for the 18 variables is indicated for the six time periods. Of 108 possible changes, there were 41 obtained at the .10 level of significance or better, with 34 of them in the expected direction. This over-all result is associated with a probability less than .01. Tests of significance for individual time periods suggest that our distributions differ from chance (in the expected direction) for all comparisons except the three months post to one year. Some tendency toward increased ego boundaries at the two-week posttesting is noted, as indicated by a probability value between .10 and .20.

That postoperative meaningful memory and learning ability show improvement over the pretest levels, as manifested in six test variables, is clearly seen in Table 3. An observed shift toward increased accuracy also is found in the Draw-A-Man test, reaching a peak at three months post. The shift contrary to predicted direction in this

[6] Loss of ego boundary is defined as an experience "in which the discrimination between the consciousness of self and the consciousness of the object were (*sic*) entirely suspended, the ego being no longer separated from the nonego; the subject no longer distinct from the object; the self and the world were fused in an inseparable total complex." Quoted in *Psychiatric Dictionary* (Hinsie, L. E. and Shatzky, J. New York: Oxford University Press, 1940, p. 189) from Storch, A. *The Primitive Archaic Forms in Schizophrenia.* (Tr. by Willard, C.) New York and Washington: Nervous and Mental Disease Publishing Company, 1924.

TABLE 3

DIRECTION OF NET CHANGE IN VARIABLES RELATED TO HYPOTHESIS II: INCREASED EGO BOUNDARIES

(H indicates increased, L indicates decreased, and — indicates no change in ego boundaries)

Variable	Time Period					
	Pre–2 wk.	Pre–3 mo.	Pre–1 yr.	2 wk.–3 mo.	2 wk.–1 yr.	3 mo.–1 yr.
Expected Change	H	H	H	H	H	H
Memory						
Digit Span Forward (3)	L	L	—	—	—	—
Mem Par Immed Rights (18)	H	—	H	—	—	—
Mem Par Delay Rights (21)	—	—	H	—	—	—
Mem Par Average Rights (24)	—	—	H	—	—	—
Cognitive (Learning)						
Digit Symbol Score (2)	—	H	—	H	H	—
Halstead Right-Left (41)	—	—	H	—	—	—
Halstead Right-Both (42)	—	H	—	—	H	L
Vocabulary (17)	—	H	H	H	H	—
Body Image						
D-A-M Accuracy (65)	—	H	—	H	—	L
Contact Variables						
Rorschach Rejections (126)	H	—	—	—	—	H
Mult Choice Ror Reject (138)	H	—	—	—	—	—
Mult Choice Ror C Resp (141)	H	H	H	—	—	—
Mult Choice Ror C_u Resp (140)	—	—	—	H	—	—
Szondi p+ (105)	—	—	—	H	—	L
Szondi p− (106)	H	H	H	—	—	L
Word Assoc Pers Ref (87)	—	H	H	H	H	—
Dynamometer Level of Asp (30)	H	—	H	—	—	—
Tweezer Dext Lev of Asp (32)	—	—	—	H	—	L
Changes in Expected Direction	6	7	9	7	4	1
Changes in Opposite Direction	1	1	0	0	0	5

variable at the three-month–one-year period will be dealt with later. The changes noted in digit span forward, also opposite to the expected direction, may not be inconsistent with the hypothesis. That is, it is possible that a perseverative factor, a concomitant of weakened ego boundaries, was operative at the presurgical level. The decreased score postoperation may reflect a diminution of the perseverative tendency which (if it is, as suggested, negatively correlated with the strength of ego boundaries) may be associated with the ability to differentiate between self and non-self.

Observed changes also compare quite favorably with predicted shifts in the contact variables listed in the table. On the Rorschach, there is a tendency to reject fewer cards, to give more human content, and to offer fewer crude color responses. Interpretively these changes would indicate that the patient has more energy to invest in environmental objects, is better able to identify with human figures in the environment, is less controlled by impulsive emotional forces, and displays a somewhat greater inclination to give commonly acceptable percepts. The incidence of personal references on the Word Association Test, responses indicative of autistic thinking, decreases. The scores of two Szondi signs *p*+ and *p*− shift according to expectancy, which would seem to indicate an increased orientation toward the environment or a willingness to make contact with the outside world, with less withdrawal and projection. All of the results discussed in this paragraph may be considered as signs of increased environmental contact.

A tendency toward a higher vocabulary score suggests increased functional intelligence, and there is also a tendency to set higher goals in the tests of level of aspiration (dynamometer, finger dexterity). Related to these variables is the willingness of the patient to expend mental energy on simple tests. This was manifested by an increased number of attempted solutions on the series-completion test in the two-week–three-month period. (Series completion is not included in Table 3 because it was not one of the tests on which changes were predicted to occur.) However, on a corresponding measure for the Shipley-Hartford, where a similar but more difficult task is involved, the patients appear to be less willing to expend this mental energy. That is, in the two-week–three-month period, there is a decrease in attempts on the Shipley-Hartford at the .01 level.

The authors believe that the foregoing results tend to confirm the hy-

pothesis that ego boundaries are strengthened following prefrontal lobotomy. It will be noted in Table 3, however, that the observed shifts at the three-month–one-year period tend to be contrary to the predicted direction. While these results do not controvert the hypothesis they do necessitate modification. It appears that the strengthening of ego boundaries after operation is not a progressive process culminating in a final state of sustained improvement; rather, the improvement reaches a peak and then a trend toward decline, similar to that noted in the discussion of the first hypothesis, sets in.

The functional similarity between variables measuring organically determined malfunction and the variables measuring ego functions makes it difficult, in a clinical analysis, to separate them. Thus, we predicted more efficiency at the three months posttesting in certain tests related to the first hypothesis, but were unable to support this hypothesis. However, we do note that on tests of ego functioning related to the second hypothesis, improvement does take place. On the other hand, the predicted strengthening of ego boundaries does not hold up in the period from three months to one year postoperation, perhaps because of decreased performance on variables related to the organic hypothesis. While the individual clinician may be able to predict over-all efficiency at various time limits, statistical analysis appears to be a better way to identify the mechanisms which seem to be responsible for the gross fluctuations.

In order to explain dynamically the alteration in ego structure, it is the opinion of the authors that lobotomy represents an attack upon the body image or schema, or ego, which at first seems to accentuate the schizophrenic regressive process. In the course of this regression, a hypercathexis of ego boundaries occurs—a defensive constriction of the self—that serves to make sharper distinction between that which is ego and that which is nonego. This opinion is consistent with the thinking of Frank (8) and Reitman (28).

C. Hypothesis III

The third hypothesis to be examined is that lobotomy results in an increased sexual awareness and an increased differentiation, in the patient's mind, between masculinity and feminity. To test this hypothesis the senior author selected and predicted the direction of change in eight variables which, from his experience and from clinical opinion appearing in the literature, would seem to be related to awareness of sexuality. The results of the statistical analysis are found in Table 4, where the observed direction of shift in the eight selected variables is indicated for the six time periods. Of the 48 possible shifts, we observe 18 at the .10 level or better, with 16 in the expected direction. This over-all result is presumed to be significant at the .01 level. However, since only the pre to two-week and the pre to one-year results are significant by themselves (with a probability less than .10) the support for the hypothesis can be considered to be only tentative.

In support of the hypothesis the results show decreased sexual confusion on the Draw-A-Man test, less difficulty with angles on the Bender, and a decreased reaction time to Rorschach card VI. There is an increase in the size of the breast on the female figure and an improved conception of the body image (more accurate drawing of the man). Greater concern over sexuality is demonstrated in increased aversion toward masturbation, and there is a tendency toward a higher incidence of sex responses on the multiple-choice Ror-

TABLE 4

DIRECTION OF NET CHANGE IN VARIABLES RELATED TO HYPOTHESIS III: SEXUAL AWARENESS AND DIFFERENTIATION

(H indicates more, L indicates less, — indicates no change in sexual awareness)

Variable	Time Period					
	Pre–2 wk.	Pre–3 mo.	Pre–1 yr.	2 wk.–3 mo.	2 wk.–1 yr.	3 mo.–1 yr.
Expected Change	H	H	H	H	H	H
Aversion to Masturbation (122)	H	—	—	—	—	L
B-G Angle Difficulty (77)	H	—	H	—	—	H
D-A-M Sexual Confusion (66)	—	H	H	—	—	—
D-A-M Accuracy (65)	—	H	—	H	—	L
D-A-M Nose Size (64)	H	—	—	—	—	—
D-A-W Breast Size Shift (61b)	H	—	H	H	H	—
Rorschach T/1R, Card VI (132)	—	—	H	—	—	H
Mult Choice Ror, Sex Resp (144)	—	—	—	—	H	—
Changes in Expected Direction	4	2	4	2	2	2
Changes in Opposite Direction	0	0	0	0	0	2

schach. The size of the nose, a phallic symbol, on the drawn male figure shows a tendency to increase.

By way of dynamic explanation of these results, it appears that prior to the operation the schizophrenic has regressed to a state of undifferentiated sexuality. The lobotomy apparently activates a reintegrative process whereby the patient progresses from the undifferentiated state to a level where there is some awareness and concern over sexual matters, particularly as regards the role which the patient assumes. It may be that the lobotomy reactivates conflicts related to castration anxiety and biological survival, affording the opportunity for a more realistic, less schizophrenic solution to those problems which contributed to the original development of the disease process. Kempf (19) has pointed out the importance of these issues for recovery in schizophrenia.

D. HYPOTHESIS IV

The last of the four major hypotheses holds that there is an increase in the rate of action or behavior, or a diminution of inhibitory factors, following lobotomy. This was readily apparent in the patients' general postoperative test behavior. They were hasty and impulsive, disliked being blindfolded, and reacted negatively toward electrical contacts and repetitive, monotonous tasks.

Fourteen variables were selected by the senior author to test this hypothesis, and the direction of change was predicted. These variables, it was reasoned, were those which would best reflect alterations in the speed of action. (Rorschach cards I and II were not used as variables in this study because of the change in test conditions required by this technique. Subjects were called out individually from the group tests to be examined by a different examiner in a different room. Many subjects appeared to have difficulty with the first two Rorschach cards while making adjustment to the new situation. Cards III through X inclusive did not show this difficulty and are therefore included as variables for this hypothesis.) The results of the statistical analysis are found in Table 5. Of the 84 possible changes, 37 are observed at the .10 level or better, with 30 in the expected direction. This over-all result is presumed to be significant at the .05 level. The individual time periods are significant with the exception of the pre to two-week and

TABLE 5

DIRECTION OF NET CHANGE IN VARIABLES RELATED TO HYPOTHESIS IV: INCREASED RATE OF ACTION

(H indicates increased, L indicates decreased, — indicates no change in rate of action)

Variable	Time Period					
	Pre–2 wk.	Pre–3 mo.	Pre–1 yr.	2 wk.–3 mo.	2 wk.–1 yr.	3 mo.–1 yr.
Expected Change	H	H	H	H	H	H
Motor						
Downey Time for USA (35)	—	H	—	—	—	—
Downey Total Time (36)	H	H	—	L	L	L
Finger Dexterity (29)	—	H	H	H	H	—
Cognitive						
Serial Seven Time (6)	H	H	H	H	H	H
Word Assoc Time (88)	L	—	—	H	H	—
Digit Symbol Score (2)	—	H	—	H	H	—
Reaction Time, Rorschach						
Card III (129)	H	—	H	—	H	—
Card IV (130)	H	H	—	—	L	—
Card V (131)	H	—	—	—	—	H
Card VI (132)	—	—	H	—	—	H
Card VII (133)	—	L	—	—	—	—
Card VIII (134)	—	—	—	H	—	—
Card IX (135)	L	—	—	—	H	—
Card X (136)	—	—	—	—	H	—
Changes in Expected Direction	5	6	4	5	7	3
Changes in Opposite Direction	2	1	0	1	2	1

the three-month to one-year post comparisons.

Supportive evidence for this hypothesis is found in the decreased reaction times for several of the Rorschach cards, in the consistent speeding up of the time for serial sevens, in the reduction of time scores for the Word Association Test, and in the increased score on digit symbol (which is in part a function of speed). Also, there is increased speed in finger and tweezer dexterity; the time is faster for the Downey speed task; the change in the inhibition score on the Downey indicates freer action. Although the inhibition score on the Downey tends to increase following the two weeks post-testing, the one year post level is still lower than the pre score. Perhaps related to the lack of motor inhibition is the expansiveness shown on the Draw-A-Man, where there is a steady increase in the size of the drawing. These results are consistent with the theories of Cobb and the work of Robinson as presented by Freeman and Watts (9).

While the primary concern thus far has been motor speed and inhibition, there is some reason to believe that there may be a corresponding lack of inhibition in the moral-social field. Support for this notion is found in the Aversion Test, where lobotomized patients indicate less aversive attitudes towards certain asocial activities such as theft, eating cooked human flesh, murder, masturbation, and deviant sexual behavior. Only with respect to masturbation is there an exception to this trend, towards which there is more aversive feeling from the pre-operative period to the period two weeks later.

There is evidence to suggest that, while the rate of action has been somewhat altered by lobotomy, the patient's basic personality is not radically changed. It was noted, for example, that although the Rorschach reaction times were reduced, the rank order for the reaction times to the individual cards remained the same. It may be, then, that

what lobotomy does is to permit freer action of the pathological prelobotomized personality core rather than effect any essential change of structure.

The authors observed, in a gross clinical way, that the patients after lobotomy apparently were not concerned with realistic plans for the future. Dr. James C. Fox, Jr., consultant in neurology and psychiatry at the Northampton VA Hospital, noting that the authors had not included in their battery a test which would reveal attitudes toward the future, suggested the Robinson-Freeman questionnaire (9). It was determined in a subsequent study which employed this technique that lobotomized patients do in fact manifest significantly less concern with the future than do control patients who are tested at the same time interval.

E. Residual Variables

The reader will recall that 145 variables are listed in the section on test materials (III, C, above). We have discussed so far the changes observed in 73 variables. Twenty-two additional variables, also showing significant changes, all pertain to the Szondi technique and will not be discussed here. Five more are functions of variables already discussed, e.g., average reaction time in Rorschach, difference between immediate and delay memory, etc. The remaining 45 variables were used in setting up hypotheses either in the longitudinal analysis or the intra-individual analysis, and were not subjected to statistical test. The reader should not infer, however, that no other variables were used in the first two phases of the analysis, for this was not the case.

V. DISCUSSION

It will be recalled that the authors cited, at the beginning of this paper, three major criticisms of the literature in the area of psychosurgery. Let us reiterate these criticisms and consider them in the light of the results of the present experiment. First, the disagreement between experimenters as to the nature of the changes in psychological tests following lobotomy seems to be, in part at least, a function of the length of interval between testings. As we have seen from the support of our first hypothesis, test scores change from one postoperative period to another. Thus experimenters who examine patients six months after operation may be expected to obtain different results from those of investigators who use the same tests at three months or one year postoperation. A second factor contributing to conflicting results is the matter of control patients. We found that our control patients varied considerably from one testing to another and these changes had to be taken into account in evaluating the changes in lobotomized patients. Studies which fail to consider the variability found in non-lobotomized psychotic patients will often arrive at erroneous conclusions as to the effect of prefrontal lobotomy.

A second major criticism raised in the literature is that important psychological variables have been neglected. The wide variety of tests used in this study and the many significant test changes observed would indicate that there are available in the psychologist's armamentarium many techniques for examining the effect of lobotomy. However, the present study unfortunately lacked measures of social dynamics. The work of Greenblatt and his associates (13) on sociometric constellations may offer a methodology for the study of such factors.

The third major criticism, dealing with the lack of congruence between clinical observations and test data, is only partially answered by the comprehensive test battery used in the present study. Although we tested a variety of functions, we were concerned primarily with the cognitive sphere, examining such attributes as attention, concentration, memory, etc. We also attempted to investigate, however, certain personality alterations of the type which have been noted clinically, such as apathy, inertia, decreased level of effort, lack of concern about the future, etc. We found support for three kinds of test changes which were related to the issues of clinical evaluation: (*a*) patients tend to react faster, (*b*) patients show some increased concern over sexual issues, and (*c*) there is an increase in social contact. Unfortunately, we are unable to determine at this point the ethical significance of these changes, although on some of our tests, such as the Aversion Scale, we noted increased acceptance of antisocial attitudes.

Furthermore, we are almost completely unable to measure such things as—to mention only two—anxiety and creativity. Both of these are all-inclusive, elusive terms whose meaning is not at all clear to psychologists or psychiatrists. We can measure related atomistic variables such as foresight, planning, tension, changes in PGR, etc., but we cannot capture the essence of the gestalten. Clinical inferences which are made concerning the presence of anxiety, for example, are usually made on the basis of case studies, whereas a particular test response connotes anxiety only when it is found in a particular matrix. For this reason, a considerable amount of inferential thinking is done, and one can never be quite certain of the reliability and validity of one's conclusions. An interview technique of some type might be used to study this important area.

Last, we would like to consider a limitation of the experimental method used in this study. This limitation is a function of the relative homogeneity and heterogeneity of the subjects. For certain variables (those more closely related to biological factors) our group is sufficiently homogeneous, but for other variables (those more psychosocial in nature) our groups are probably too heterogeneous. The changes found in this experiment that have been discussed above were changes in groups. It should not be forgotten that, in so far as personality status is concerned, there is relatively little consistency from one patient to another. It appears that the preoperative personalities of the schizophrenics are so highly individualized that they have their own peculiar mode of reaction to the operation per se. Moreover, our present qualitative methods do not appear able to assess the direction or severity of the regression so that we might understand the specific determining role of the operation.

There is still another factor which has been neglected in explaining what happens following lobotomy. This is the matter of the interaction between the personality and its social environment. We have seen that the lobotomy operation is accompanied by considerable, though temporary, organic changes. These produce alterations in the way in which the patient handles his environment. The reaction of other individuals in the environment will, in turn, alter the patient's self-concept and goals, and so will result in a new personality configuration which will then produce still different modes of behavior. Although these new modes of reaction result from

a surgical assault upon the organism, they are more directly a function of the reciprocal impact of personality and environment. That is, the operation sets off a chain reaction in which the traumatic event, the operation, plays a comparatively minor role. Although we have not grappled comprehensively with this issue, our results do suggest that the interaction between the environment and the behavior of the lobotomized patient can explain a good deal of the ultimate behavior of the patient. Thus, the changes which we see at one year postoperation are not so much the results of neurological degeneration as they are the attempts of a more uninhibited personality at three months postlobotomy to make new adjustments to his environment. At one year, then, we are faced with secondary personality characteristics which are "reaction formations" to the debilitation of the two-week interval and the lack of inhibition, the extraversion, and the expansiveness of the three-month period. Only a study of changes at intervals beyond one year will give us any information about the permanency of the changes noted thus far. Prediction on the basis of our present information is almost impossible because of the individual modes of reaction and the influence of the social forces which act upon each patient differently.

VI. SUMMARY AND CONCLUSIONS

An experiment was performed to study the effects of prefrontal lobotomy on white, male schizophrenic patients. Twenty-two patients, the experimental group, underwent a standard open Lyerle-Poppen prefrontal lobotomy. The control group of 22 patients was fairly well equated for age, education, length of hospitalization, diagnosis, cooperative level, and certain behavioral characteristics. All 44 patients had been approved for lobotomy by a board of psychiatrists following an unsuccessful course of electroconvulsive shock treatment, and were receiving the same types of adjunct therapy.

All experimental subjects received an intensive battery of psychological tests *before operation, and also two weeks, three months, and one year following operation.* Control patients were tested at comparable intervals. The battery consisted of 29 major tests from which 145 variables were derived. Owing to lack of cooperation or unavailability of the subjects, not all patients received all tests or could be scored for all variables on each occasion.

There was a threefold analysis of data which allowed for successive verification of hypotheses by independent judges using different samples of the total population. In the first phase of the analysis, the senior author derived certain tentative conclusions as to the nature of the changes which occur in the reorganization of personality following lobotomy. His conclusions were based on an intensive integrated analysis of all available psychiatric and psychological data for a small sample of the lobotomized group. A less exhaustive analysis was made for the remainder of the lobotomized group.

Concurrently, independent judges carried on longitudinal analyses of major tests, utilizing the data from all experimental and control patients who were tested at least once. Here certain impressions were gathered concerning change or lack of change in variables reflecting adjustment in such areas as motor, social, etc. Those impressions which were in

accord with the tentative conclusions derived from the intra-individual analysis were retained as working hypotheses. Four hypotheses were thus evolved. On the basis of these hypotheses, the senior author made predictions as to the nature of change in each of 73 variables. These predictions were then subjected to statistical test. Twenty-two variables pertaining to changes in the Szondi Test were not discussed in this paper. The remaining 50 variables include five which are linear functions of other measures and 45 which were used in setting up hypotheses and were not statistically tested.

The final stage of the threefold method of successive verification involved finding the statistical significance of the *net change* in the experimental group from one administration of tests to a later administration. The standard error of the difference between the experimental-group change and the control-group change was calculated. Changes in dichotomized data were evaluated by a formula measuring the statistical significance of the net change in proportions. Here again the standard error of the difference is based upon pre and post scores of both populations. The data used in this phase of the analysis were those obtained from patients who were tested on at least two occasions.

The conclusions reported in this paper are the end product of the threefold process—i.e., the results of statistical tests of the four hypotheses which had been evolved from the extensive case analyses and from the longitudinal analyses of test performance.

1. There is a predictable pattern of test performance following lobotomy. Performance on tests measuring mental efficiency and organicity (malfunction due to organic factors) drops sharply during the two-week postoperative period. As recovery from the operation takes place, test performance returns to the preoperative base line or rises slightly above it, reaching a peak, in our study, at three months postoperation. There then appears to be a trend toward decline, such that the performance in some tests at one year postoperation falls below the base line, although several tests remain above. It is believed that the tests which drop following the three-month peak reflect permanent organic deficit.

2. There is an increase in ego boundaries (ability to differentiate between self and non-self) following operation, as shown by better performance in tests reflecting degree of contact with the environment. There is a tendency toward increased contact immediately after lobotomy which continues throughout the three-month postoperative period. The results at one year postoperation are somewhat less clear-cut, but there appears to be a decline in test performance at this time.

3. There is an increased rate of action (with no increase in accuracy) postoperation such that lobotomized patients are able to accomplish more in a given length of time. This increased motoric speed begins shortly after operation, reaches a peak at three months postoperation, and then tends to decline. Analysis of projective tests suggests that there is no essential reorganization of the basic personality, although lobotomized patients are more impulsive, less concerned with the future, and less averse toward asocial thought and behavior.

4. There is increased awareness of sexuality following lobotomy, which seems to be maintained for at least three months. As in the conclusions reported

above, the course following three months is somewhat uncertain. Dynamically, this finding seems related to anxiety over issues of castration and biological survival.

The authors recognize certain weaknesses in this study, such as the lack of measures of social dynamics, the inability of our test battery to determine the ethical significance of changes following lobotomy, and the failure to measure global variables such as anxiety or creativity. A further limitation is found in the experimental method in that individual reactions to the lobotomy, stemming from the highly individualized prelobotomy personality of each patient, are not fully considered. To some extent, however, the clinical analysis of each patient (which formed the first part of the threefold analysis) does take individual reactions into account. Related to this is the matter of interaction between the personality after lobotomy and the environment; it appears that changes at any one period may be partly determined by reactions of persons in the environment to behavior of the individual. A projected study of changes beyond one year will throw light on this matter and will also give information as to the permanency of the reported changes. This study—as well as validation, in an independent group, of our present findings—is now in progress.

APPENDIX A

The following report, excerpted from a forthcoming article (abstracted in [31]), illustrates the qualitative analysis of a single case using data from psychological tests, psychiatric observations, and case history material.

The patient is a 35-year-old, single male who completed three years of high school. He became mentally ill after three months of army service, complaining of depression, suicidal preoccupation, insecurity, and strange feelings; and was hospitalized with a diagnosis of schizophrenia. Later he alternated between periods of hyperactivity and apathetic inaction, developed delusions of syphilitic infection, and felt that his pelvis was tipped. It was also determined that he had been disturbed about masturbatory practices since age six, and was quite concerned over the suicide of an 11-year-old brother. At this hospital, he was unsuccessfully treated with insulin subshock and electroconvulsive therapy, and was lobotomized in December 1948.

His general test behavior at the four time intervals approximated that of a normal individual. He was cooperative, alert, attentive, and expended a considerable amount of effort on the tests.

Let us now consider the patient's drawings of the male human figure. Comparing the drawings before lobotomy and two weeks after, we note that on the post drawing, the hair has been shaved off, there is a large concavity at the approximate site of the operation, and that the nose has been elongated. Assuming that the observed changes are attributable to the intervening lobotomy, it may be posited that they express the patient's conscious or unconscious response to the biological assault in terms of his body image. That is, the reflection of actual body changes in the drawings—the absence of hair and the alteration of skull contour—would seem to substantiate the notion that the drawn figure is a projected conception of the self. If we assume that the nose is a phallic symbol, then the postoperative lengthening of the nose would indicate that lobotomy occasions personality changes related to psychosexual status. It is interesting to compare his drawings with a response to card IV of the Rorschach. To the same area where he had reported "a cow's head" prior to lobotomy, he responded postoperation, "Old man, big nose, eyes are tight, just about ready to get out of a deep sleep." This would seem to lend support to the hypothesis that responses to projective techniques are at least in part determined by the self-concept.

An analysis of the patient's responses to the Tendler Emotional Inquiry affords us another insight into the effect of lobotomy upon the personality. Before operation the patient characteristically expressed, in his completion of sentences, undifferentiated feelings and attitudes of a primitive, regressed nature. After operation his responses were better structured, less ambiguous, and more pertinent to the stimulus demand of the sentence fragments. His ego had seemed to become less amorphous; there was greater ego control with reduction of chaotic primitive thinking.

It will be interesting to dwell for a moment on the response of the patient to one particular item in the Aversion Scale. The item in question is: "Somebody in your immediate family (sister, brother, father, mother) asks you to have sex relations with them, you oblige." When questioned before operation about his attitude, he responded in such a way as to indicate that he would be only slightly concerned over incest. At the two weeks posttesting, however, he expressed distaste for this idea by marking the score at the extreme adverse end of the scale with many heavy rounded strokes. The motoric elaboration alerted the author to the possibility that incest fantasy or an incestual act might be playing an important role in this case. To this end a careful check of the psychiatric record, especially amytal interviews and electroconvulsive therapy postcoma verbalizations, was made, revealing the following information. At the age of six, the patient had had TB and was confined to bed. He said that all he could think of at that time was sex, and that, longing for it one day and telling his mother about it, he asked her to lie down upon the bed naked. She complied with his wish, he went on, and then he had had sexual relations with her. The fact that this peculiar response occurred only at the two-week testing suggests that the immediate effect of lobotomy is to lower the threshold for the expression of repressed material. It would appear, too, that biological assault increases the sensitivity of the organism to events in the present which are related to previous emotional trauma.

APPENDIX B

The following example of the type of information gathered in the longitudinal analysis of test performance is summarized from the report submitted by Alfred Goldman, intern clinical psychologist. Similar analyses were made for each of the 29 major tests in the battery.

Analysis of Individual Rorschachs

Limitations

The following factors limit the validity and number of inferences which may be made from the data.

A. The sequence or training effect:

Since the same technique was used repeatedly, the effect of the prior administrations upon subsequent test results must be considered. There is evidence that the memory effect was rather substantial (e.g., giving a response to card IV that had previously been given to card III in a prior administration). Aspects of test performance which are particularly sensitive to this effect are:

1. Reaction time, which may be reduced because of increased familiarity.
2. Content, which may be affected by the memory of previous responses.

B. The effect of different examiners:

1. It is recognized that a Rorschach protocol is affected to some degree by the personality of the examiner.
2. Several divergent methods of administration, inquiry, and scoring were utilized by the different examiners at the various time periods. This could have been controlled only by using the same examiner at all times.

Variables Considered and Tentative Conclusions

A. Contact, as reflected in various aspects of test performance mentioned below:

1. Although markedly increased *P* (ability to accept and express conventional modes of thought) is found in only two records, there is some slight over-all tendency to offer more conventional concepts. The mode of expression is also somewhat more conventional.
2. Style of verbalization indicates, in about 40 per cent of the records, a more tentative attitude toward percepts (reflected in the use of "might be a bat, could be a dog," etc., as compared with "is a bat, is a dog," etc.).
3. Stylistic factors as well as other types of evidence suggest that some patients drop a certain quasi-omniscient quality from their verbalization.
4. Form accuracy (*F+*) is increased in 15 per cent of the control group, with another 10 to 15 per cent tending in that direction. No such change is observed in the experimental group.
5. Only two cases show clear evidence of increased organizing ability (*Z*).
6. Sensitivity to subtler nuances in the environment (*Fc*) presents a divergent picture. Statistical treatment might indicate a bimodal distribution.
7. Although 60 per cent of the control cases indicate some increase in differentiation and/or elaboration of concepts (i.e., "animal" to "dog," "man" to "man bending down with black suit on"), none of the experimental cases show this.

B. Expression of impulse:

There seems to be more facile expression of impulse as manifested by:

1. A slight although inconsistent decrease in reaction time.
2. Increased animal movement responses (*FM*).
3. Increased control over diffuse emotionality in some records (decrease in *CF* relative to *FC*).

Other factors require consideration since they appear to contraindicate the above findings:

1. In 25 per cent of the cases there is consistent increase of *CF*, C_d, and C_s responses. This raises the question whether the increased control of emotionality is control per se, or whether the patients are merely less stimulated by color.

2. One of the most consistent findings was a decrease of morbid interest in sexuality (homo- or hetero-). This raises the question whether there is modification of impulse expression, or whether there is change in the nature of the impulse expression, or whether there is change in the nature of the impulse. There is, however, greater sex content at two weeks postlobotomy, which generally drops out by one year postoperation.

3. In three of the "improved patients" an interesting factor is observed: the emergence of an emotional superficiality that was not present before lobotomy—for example, increased *F/C* and *C/F* responses, increased Map and Medical Book content, etc. This suggests a new type of reorganization, a more successful facade.

C. Anxiety:

1. From a summary analysis of the individual Rorschachs it appears that some patients are less threatened by the environment.

2. An apparent decrease in anxiety is a concomitant of this. This is the most salient change in the experimental records.

D. Organic signs:

1. In some patients, there appears to be some awareness of assault, as reflected in increased attention to or anxiety about the head.

2. Increased concreteness.

3. Increased perseveration. Here, as in *Fc*, there is something of a bimodal distribution.

E. Flatness:

This factor, in addition to the anxiety factor, is one of the most consistent ones found. In all patients in which the affective quality of the protocols change, the direction is towards flattening. Associated with this are the following three observations:

1. One year postoperative protocols seem to be less imaginative and creative than the preoperation records.

2. There is less overt expression of aggression.

3. One year post protocols closely approximate those of the "burned out" praecox, while many of the pre records resemble protocols of excited schizophrenics.

F. Social Maturity:

There is some slight indication that the level of social maturity is somewhat higher, as manifested by an increase in constructive concepts. For example, instead of "men fighting, pulling" we find "men lifting, washing together," etc.

Conclusion: The Importance of the Unique Personality

It is assumed that the operation has psychological meaning in terms of physical assault. Just what this assault will mean, i.e., how it will be interpreted by the patient, is a function of the unique personality structure. Any statistical or pseudomathematical evaluation of Rorschach protocols may tend to mask changes associated with the physical assault, since it appears that the operation affects patients in different ways. No significant interpatient consistency was found which could be attributed to the operation.

Analysis of the data suggests that reactions to lobotomy are highly individualized and dependent largely upon the premorbid personality structure and the particular symptomatology. Thus, one patient changed in the direction of greater approximation to his potential, while another, with a similar premorbid personality, lost most of the potential that had been present, though unrealized, in the preoperative protocol. It is felt that an analysis of individual records from the point of view of the meaning of the physical assault might prove useful in understanding the way in which this experience is integrated during the reorganization of personality following lobotomy.

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